

I claim:

1 1. A circulating switch comprising:

2 a plurality of switch modules; and

3 a temporal cyclical rotator having a plurality of inlets and a plurality of outlets,
4 where each inlet of said plurality of inlets is communicatively connected to
5 each switch module of said plurality of switch modules and each outlet of said
6 plurality of outlets is communicatively connected to said each switch module
7 of said plurality of switch modules and where said temporal cyclical rotator is
8 operable to cyclically connect each switch module of said plurality of switch
9 modules to each other switch module of said plurality of switch modules by
10 cyclically connecting individual inlets among said plurality of inlets to individual
11 outlets among said plurality of outlets.

1 2. The circulating switch of claim 1 wherein said each switch module of said plurality
2 of switch modules is a common memory switch module.

1 3. The circulating switch of claim 1 wherein said single temporal cyclical rotator is
2 an electronic rotator.

1 4. The circulating switch of claim 1 wherein said single temporal cyclical rotator is a
2 photonic rotator.

1 5. The circulating switch of claim 1 wherein:

2 said temporal cyclic rotator is adapted to connect said each switch module of
3 said plurality of switch modules to said each other switch module during a
4 rotation cycle comprising a plurality of rotation phases; and

5 during a given rotation phase among said plurality of rotation phases, wherein
6 said each switch module is connected through said temporal cyclic rotator to a
7 respective switch module determined according to a predefined rotation
8 configuration, said each switch module is operable to:

9 receive at most one data segment from a subtending data source;

10 transmit at most one data segment to a subtending data source; and
11 transmit at most two data segment to said respective switch module.

1 6. The circulating switch of claim 5 wherein said each switch module is further
2 operable to transmit a given data segment to said respective switch module, where
3 said given data segment is destined to switch module distinct from said respective
4 switch module.

1 7. The circulating switch of claim 6 wherein said each switch module is further
2 operable to:

3 receive indicative data segments from another switch module among said
4 plurality of switch modules, each of said indicative data segments including an
5 indication of a sequential order; and

6 reorder said indicative data segments according to said indication.

1 8. The circulating switch of claim 1 further comprising:

2 a plurality of module controllers, each module controller of said plurality of
3 module controllers associated with a switch module of said plurality of switch
4 modules;

5 a master controller communicatively connected to said each module controller
6 of said plurality of module controllers, where said master controller is operable
7 to indicate to said plurality of module controllers a schedule according to
8 which each switch module of said plurality of switch modules cyclically
9 connects to each other switch module of said plurality of switch modules.

1 9. The circulating switch of claim 8 wherein said master controller is directly
2 connected to said each module controller of said plurality of module controllers.

1 10. The circulating switch of claim 8 wherein said master controller subtends to one
2 of said switch modules and receives control signals through said one of said switch
3 modules.

1 11. The circulating switch of claim 8 wherein said master controller connects to said
2 temporal cyclic rotator and receives control signals through said temporal cyclic
3 rotator.

1 12. A circulating switch comprising:

2 a plurality of switch modules; and

3 an array of temporal cyclical rotators, where each temporal cyclical rotator of
4 said array has a plurality of inlets and a plurality of outlets, where said plurality
5 of inlets and said plurality of outlets are communicatively connected to said
6 plurality of switch modules and where said each temporal cyclical rotator is
7 operable to cyclically connect each switch module of said plurality of switch
8 modules to each other switch module of said plurality of switch modules by
9 cyclically connecting individual inlets among said plurality of inlets to individual
10 outlets among said plurality of outlets.

1 13. The circulating switch of claim 12 further comprising:

2 a plurality of module controllers, where each module controller of said plurality
3 of module controllers is associated with a corresponding switch module of
4 said plurality of switch modules; and

5 a master controller communicatively coupled to said each module controller.

1 14. The circulating switch of claim 12 wherein said each temporal cyclical rotator of
2 said array has a predetermined number of input ports and a predetermined number
3 of output ports and wherein each input port of said number of input ports connects to
4 each of said output ports according to a predetermined connectivity matrix defined
5 for a given rotation cycle.

1 15. The circulating switch of claim 14 wherein said rotation cycle comprises a number
2 of rotation phases of equal duration and wherein during each of said rotation phases
3 said each input port connects to a respective output port of said number of output

4 ports determined according to rotation connectivity specific to said each temporal
5 cyclic rotator.

1 16. The circulating switch of claim 12 wherein said each switch module of said
2 plurality of switch modules is operable to:

3 receive a succession of data segments;

4 receive a schedule; and

5 transmit said data segments according to said schedule.

1 17. The circulating switch of claim 13 wherein:

2 each switch module of said plurality of switch modules is adapted to organize
3 data received from data sources into data segments; and

4 said each module controller associated with said corresponding switch
5 module is operable to communicate identifiers of said data segments to said
6 master controller.

1 18. The circulating switch of claim 17 wherein said each module controller associated
2 with said corresponding switch module is further operable to:

3 send requests to said master controller for scheduling said data segments;

4 receive a schedule from said master controller for transmitting said data
5 segments; and

6 cause corresponding switch module to transmit said data segments according
7 to said schedule.

1 19. The circulating switch of claim 18 wherein said each master controller is
2 operable to:

3 receive from at least one module controller requests for scheduling said data
4 segments;

5 determine a schedule for transmitting said data segments; and

- 6 communicate said schedule to each of said at least one module controller.
- 1 20. The circulating switch of claim 18 wherein said each master controller is operable
2 to:
- 3 receive a flow-rate-allocation request from a given switch module among said
4 plurality of switch modules;
- 5 allocate a permissible transfer rate in response to said flow-rate-allocation
6 request;
- 7 communicate said permissible transfer rate to said given switch module;
- 8 determine a data transfer schedule specific to a source switch module and a
9 destination switch module among said plurality of switch modules; and
- 10 communicate said data transfer schedule to said source switch module and
11 said destination switch module.
- 1 21. The circulating switch of claim 12 wherein each switch module of said plurality of
2 switch modules comprises one ingress module and one egress module.
- 1 22. The circulating switch of claim 12 wherein at least one temporal cyclical rotator of
2 said plurality of temporal cyclical rotators is programmable for change of cyclic input-
3 output connectivity.
- 1 23. The circulating switch of claim 12 wherein each switch module of said plurality of
2 switch modules is a common memory switch.
- 1 24. The circulating switch of claim 23 wherein each common memory switch of said
2 plurality of switch modules has a data memory logically divided into:
- 3 a first section for storing a first set of data segments, where said first set of
4 data segments are received from data sources;
- 5 a second section for storing a second set of data segments, where said
6 second set of data segments are destined for particular switch modules
7 among said plurality of switch modules, said second section logically divided

8 into a number of sub-sections, each sub-section of said number of sub-
9 sections corresponding to one temporal cyclical rotator among said plurality of
10 said temporal cyclical rotators; and

11 a third section for storing data segments directly destined for data sinks.

1 25. The circulating switch of claim 24 wherein each of said sub-sections has a
2 storage capacity sufficient to store a data segment for said each switch module of
3 said plurality of switch modules.

1 26. The circulating switch of claim 25 wherein said array of temporal cyclical rotators
2 comprises an even number of temporal cyclical rotators arranged in a number of
3 complementary pairs of temporal cyclical rotators and wherein each of said
4 complementary pairs of temporal cyclical rotators includes a clockwise temporal
5 cyclical rotator and a counterclockwise temporal cyclical rotator and wherein:

6 said clockwise temporal cyclical rotator connects each switch module of said
7 plurality of switch modules to each other switch module of said plurality of
8 switch modules in an ascending sequential order; and

9 said counterclockwise temporal cyclical rotator connects each switch module
10 of said plurality of switch modules to each other switch module of said plurality
11 of switch modules in a reverse order of said ascending sequential order.

1 27. The circulating switch of claim 26 wherein:

2 data segments received at said each common memory switch through said
3 clockwise temporal cyclical rotator are written in a given sub-section of said
4 number of sub-sections, where said given sub-section is associated with said
5 counterclockwise rotator; and

6 data segments received at said each common memory switch through said
7 counterclockwise temporal cyclical rotator are written in a particular sub-
8 section of said number of sub-sections, where said particular sub-section is
9 associated with said clockwise rotator.

1 28. The circulating switch of claim 25 wherein:

2 said array of temporal cyclical rotators comprises a first set of clockwise
3 temporal cyclical rotators and a second set of counterclockwise temporal
4 cyclical rotators;

5 and wherein:

6 each clockwise temporal cyclical rotator of said first set of clockwise temporal
7 cyclical rotators connects said each switch module to said each other switch
8 module in an ascending sequential order; and

9 each counterclockwise temporal cyclical rotators of said second set of
10 counterclockwise temporal cyclical rotators connects said each switch module
11 to said each other switch module in a reverse order of said ascending
12 sequential order;

13 and wherein:

14 an indirect connection from one switch module of said plurality of switch
15 modules to another switch module of said plurality of switch modules
16 traverses one clockwise temporal cyclical rotator of said first set of clockwise
17 temporal cyclical rotators and one counterclockwise temporal cyclical rotator
18 of said counterclockwise temporal cyclical rotators.

1 29. A method of switching comprising cyclically connecting each switch module
2 belonging to a plurality of switch modules to each other switch module of said
3 plurality of switch modules such that, in a given time slot, said each switch module is
4 connected to a subset of said plurality of switch modules.

1 30. The method of claim 29 wherein said connecting occurs during at most a
2 specified number of time slots in a time frame having a predefined number of time
3 slots and said method further comprises:

4 receiving data segments at said each switch module, each of said data
5 segments destined to a specified switch module in said plurality of switch
6 modules; and

7 sending, from said each switch module to said specified switch module, a
8 number of said data segments such that said number of said data segments
9 does not exceed said specified number of time slots during said time frame.

1 31. The method of claim 30 wherein, during each of said time slots, said each switch
2 module connects to a subset of said switch modules, said subset comprising a
3 number of switch modules not exceeding said specified number of time slots.

1 32. The method of claim 31 wherein, at a given switch module of said plurality of
2 switch modules, said receiving further comprises:

3 writing a first data segment, received from a data source subtending to said
4 given switch module, in a shipping section of a memory device associated
5 with said given switch module;

6 writing a second data segment, received from one of said switch modules, in
7 a transit section in said memory device; and

8 writing a third data segment, received from another of said switch modules, in
9 a receiving section in said memory device.

1 33. The method of claim 32 wherein said sending further comprises:

2 addressing said first data segment to one of a transit section and a receiving
3 section of a memory device associated with a first switch module in said
4 subset of switch modules, said first switch module specified in said first data
5 segment; and

6 addressing said second data segment to a receiving section of a memory
7 device associated with a second switch module in said subset of switch
8 modules, said second switch module specified in said second data segment.

1 34. The method of claim 33 further comprising storing said second data segment in
2 said memory device associated with said given switch module for a period of time
3 not exceeding the duration of said time frame.

1 35. The method of claim 34 further comprising limiting a number of data segments
2 written in said transit section so that the number of data segments having the same
3 destination switch module does not exceed said specified number of time slots.

1 36. The method of claim 32 wherein said predefined number of time slots is
2 equivalent to a number of switch modules in said plurality of switch modules.

1 37. The method of claim 30 wherein said predefined number is in the range of 16 to
2 1024 and said specified number is in the range of 2 to 8.

1 38. The method of claim 30 further comprising selecting the time slots in said
2 specified number of time slots to be substantially equidistant from each other along
3 said time frame.

1 39. A method of adding a new switch module to a circulating switch having a plurality
2 of switch modules that exchange data segments through an array of temporal
3 cyclical rotators, the method comprising:

4 scheduling an exchange of said data segments through said temporal cyclical
5 rotators while excluding from consideration a selected one of said temporal
6 cyclical rotators;

7 extending a rotation configuration of a selected one of said temporal cyclical
8 rotators of said array;

9 connecting an input port and an output port of said new switch module to said
10 selected one of said temporal cyclical rotators; and

11 repeating said scheduling, extending and connecting using another selected
12 one of said temporal cyclical rotators.

- 1 40. The method of claim 39 including a further step of exchanging data segments
- 2 through said selected one of said temporal cyclical rotators following said
- 3 connecting.